

Claims

We claim:

1. A database operator that selects a subset of a plurality of database objects having associated attributes comprising:
 - a partial order specification module that inputs a partial order criterion for an attribute whereby a master database object in the plurality dominates an associated slave database object; and
 - a database object subset selection module that applies the partial order criterion to the database object attributes and eliminates all slave database objects that do not dominate their associated master database object from the subset.
2. The database operator of claim 1 comprising a partitioning module that partitions the database objects into partitions based on a partitioning attribute; wherein database objects in the partition have equivalent values for the partitioning attribute and wherein the subset selection module applies the partial order separately for each partition.
3. The database operator of claim 1 comprising a dominance aggregation module that, for a master database object, aggregates information about slave database objects that the master database object dominates.
4. The database operator of claim 3 wherein information about a slave database object is distributed between two master database objects that dominate the slave object.
5. The database operator of claim 1 wherein the database objects are database statements from a database workload presented according to a workload schema.

6. The database operator of claim 1 wherein when a slave database object dominates the associated master database object, one of either the slave or master database objects is eliminated from the subset.

7. The database operator of claim 1 wherein the partial order criterion comprises a conjunction of one or more transitive inequality conditions.

8. The database operator of claim 2 wherein the partitioning module hashes database objects on the partitioning attribute.

9. A method that selects a subset of database objects from a plurality of database objects having associated attributes comprising:

- accessing two or more database objects from the plurality;
- inputting a partial order criterion for at least one attribute by which a master database object dominates a slave database object;
- applying the partial order criteria to the two or more database objects; and
- including any master database objects that are not dominated by any other database object to the subset.

10. The method of claim 9 comprising partitioning the plurality of database objects into partitions based on a partitioning attribute such that database objects in the partition have equivalent values for the partitioning attribute and wherein the partial order criteria is applied separately to database objects in each partition.

11. The method of claim 9 comprising aggregating information about slave database objects that are dominated by an associated master database object and are not included in the subset.

12. The method of claim 9 comprising selecting one of two database objects for inclusion in the subset if each of the two database objects dominates the other.

13. The method of claim 10 comprising hashing the database objects on the partitioning attribute.

14. One or more computer-readable media comprising computer executable instructions for performing the method of claim 9.

15. One or more computer readable media having computer-executable instructions stored thereon for selecting a subset of a plurality of database objects having associated attributes, the instructions comprising:

inputting a partial order criterion for an attribute whereby a master database object in the plurality dominates an associated slave database object; and
applying the partial order criterion to the database object attributes; and
eliminating all slave database objects that do not dominate their associated master database object from the subset.

16. The computer readable media of claim 15 wherein the instructions comprise partitioning the database objects into partitions based on a partitioning attribute; wherein database objects in the partition have equivalent values for the partitioning attribute and wherein the filtering module applies the partial order separately for each partition.

17. The computer readable media of claim 15 wherein the instructions comprise aggregating information about slave database objects that the master database object dominates.

18. The computer readable media of claim 17 wherein the information about a slave database object is distributed between two master database objects that dominate the slave object.

19. The computer readable media of claim 15 wherein the database objects are database statements from a database workload presented according to a workload schema.

20. The computer readable media of claim 15 wherein when a slave database object dominates the associated master database object, one of either the slave or master database objects is eliminated from the subset.

21. The computer readable media of claim 15 wherein the partial order criterion comprises a conjunction of one or more transitive inequality conditions.

22. The computer readable media of claim 16 wherein the instructions comprise hashing the database objects on the partitioning attribute.

23. An apparatus for selecting a subset of database objects from a plurality of database objects having associated attributes comprising:

- means for accessing two or more database objects from the plurality;
- means for inputting a partial order criterion for at least one attribute by which a master database object dominates a slave database object;
- means for applying the partial order criteria to the two or more database objects; and
- means for including any master database objects that are not dominated by any other database object to the subset.

24. The apparatus of claim 23 comprising means for partitioning the plurality of database objects into partitions based on a partitioning attribute such that database objects in the partition have equivalent values for the partitioning attribute and wherein the means for applying the partial order criteria applies the criteria separately to database objects in each partition.

25. The apparatus of claim 23 comprising means for aggregating information about slave database objects that are dominated by an associated master database object and are not included in the subset.

26. The apparatus of claim 23 comprising means for selecting one of two database objects for inclusion in the subset if each of the two database objects dominates the other.

27. The apparatus of claim 24 comprising means for hashing the database objects on the partitioning attribute.

28. A database operator that selects a subset of a plurality of database objects having associated attributes comprising:

an optimization criteria specification module that inputs an optimization criterion that is an aggregate function over one or more database object attributes; and

an optimization criteria solver that determines and selects as the subset a set of database objects that satisfy the optimization criteria.

29. The database operator of claim 28 comprising a partitioning module that partitions the database objects into partitions based on a partitioning attribute; wherein database objects in the partition have equivalent values for the partitioning attribute and wherein the criteria solver applies the optimization criterion separately for each partition.

30. The database operator of claim 28 wherein the optimization criterion is minimization of an aggregate over an attribute.

31. The database operator of claim 28 wherein the optimization criterion is maximization of an aggregate over an attribute.

32. The database operator of claim 28 wherein the optimization criteria specification module inputs a global constraint on the attributes of the database objects in the subset.

33. The database operator of claim 32 wherein the input global constraint is a minimum value for an aggregate of an attribute over the subset of database objects.

34. The database operator of claim 32 wherein the input global constraint is a maximum value for an aggregate of an attribute over the subset of database objects.

35. The database operator of claim 29 wherein the optimization criteria specification module inputs a local constraint on the attributes of the database objects in the subset for each partition.

36. The database operator of claim 35 wherein the input local constraint is a minimum value for an aggregate of an attribute over the subset of database objects.

37. The database operator of claim 35 wherein the input local constraint is a maximum value for an aggregate of an attribute over the subset of database objects for the partition.

38. The database operator of claim 28 wherein the optimization criteria specification module inputs a filter constraint that must be met with respect to each database object selected for the subset.

39. The database operator of claim 38 wherein the filter constraint includes an aggregate function of an attribute of the database objects being acted upon by the optimization criteria specification module.

40. The database operator of claim 28 wherein the optimization criteria solver comprises a database object ranking module that inputs an order, based on attribute values, in which database objects are accessed by the optimization criteria solver for possible selection to the subset.

41. The database operator of claim 28 wherein the database objects are database statements from a database workload presented according to a workload schema.

42. The database operator of claim 28 wherein the optimization criteria solver comprises a sampler that randomly samples database objects.

43. The database operator of claim 29 wherein the optimization criteria specification module inputs a global constraint on the attributes of the database objects in the subset; a input local constraint on the attributes of the database objects in the subset for each partition; and a filter constraint that must be met with respect to any database object selected for the subset.

44. The database operator of claim 43 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a minimum number of database objects in the subset and input local constraint is a minimum number of database objects selected per partition of database objects in the subset and wherein the optimization criteria solver selects all of the database objects for inclusion in the subset.

45. The database operator of claim 43 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a minimum number of database objects in the subset and input local constraint is a maximum number of database objects selected per partition of database objects in the subset and wherein the optimization criteria solver selects database objects in each partition in descending order of the given attribute's value for inclusion in the subset until the maximum number of database objects has been selected for that partition and verifies that the global constraint has been met.

46. The database operator of claim 43 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a maximum number of database objects in the subset and input local constraint is a minimum number of database objects selected per partition of database objects in the subset and wherein the optimization criteria solver selects database objects in each partition in descending order

of the given attribute's value for inclusion in the subset until exactly the minimum number of database objects has been selected for that partition and verifies that the global constraint has been violated and if it has not selects additional database objects in descending order of the given attribute until no more database objects can be added to the subset without violating the global constraint.

47. The database operator of claim 43 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a maximum number of database objects in the subset and input local constraint is a maximum number of database objects selected per partition of database objects in the subset and wherein the optimization criteria solver selects database objects in each partition in descending order of the given attribute's value for inclusion in the subset until the maximum number of database objects has been selected according to the global constraint and verifies that the global constraint has been met.

48. The database operator of claim 43 wherein the optimization criteria is a minimization of a count of database objects in the subset wherein the subset of database objects must meet a plurality of constraints each having a corresponding attribute that is constrained and wherein the optimization criteria solver selects database objects for inclusion in the subset by scanning, one time for each constraint, the database objects in descending order of the corresponding attribute for that constraint, and selecting database objects until the constraint is met.

49. The database operator of claim 28 wherein the criteria solver calls an integer programming solver.

50. A method that selects a subset of a plurality of database objects having associated attributes comprising:

inputting an optimization criterion that is an aggregate function over one or more database object attributes;

solving the optimization criteria with respect to the database objects; and

selecting as the subset a set of database objects that satisfy the optimization criteria.

51. The method of claim 50 comprising partitioning the database objects into partitions based on a partitioning attribute; wherein database objects in the partition have equivalent values for the partitioning attribute and applying the optimization criterion separately for each partition.

52. The method of claim 50 wherein the optimization criterion is minimization of an aggregate over an attribute.

53. The method of claim 50 wherein the optimization criterion is maximization of an aggregate over an attribute.

54. The method of claim 50 comprising inputting a global constraint on the attributes of the database objects in the subset.

55. The method of claim 54 wherein the input global constraint is a minimum value for an aggregate of an attribute over the subset of database objects.

56. The method of claim 54 wherein the input global constraint is a maximum value for an aggregate of an attribute over the subset of database objects.

57. The method of claim 51 comprising inputting a local constraint on the attributes of the database objects in the subset for each partition.

58. The method of claim 57 wherein the input local constraint is a minimum value for an aggregate of an attribute over the subset of database objects.

59. The method of claim 57 wherein the input local constraint is a maximum value for an aggregate of an attribute over the subset of database objects for the partition.

60. The method of claim 50 comprising inputting a filter constraint that must be met with respect to each database object selected for the subset.

61. The method of claim 60 wherein the filter constraint includes an aggregate function of an attribute of the database objects being acted upon by the optimization criteria specification module.

62. The method of claim 50 comprising inputting an order, based on attribute values, in which database objects are accessed by the optimization criteria solver for possible selection to the subset.

63. The method of claim 50 wherein the optimization criteria are solved by randomly sampling database objects.

64. The method of claim 51 comprising inputting a global constraint on the attributes of the database objects in the subset; a input local constraint on the attributes of the database objects in the subset for each partition; and a filter constraint that must be met with respect to any database object selected for the subset.

65. The method of claim 64 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a minimum number of database objects in the subset and input local constraint is a minimum number of database objects selected per partition of database objects in the subset and wherein the method comprises selecting all of the database objects for inclusion in the subset.

66. The method of claim 64 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a minimum number of database objects in the subset and input local constraint is a maximum number of database objects selected per partition of database objects in the subset and wherein the method comprises selecting database objects in each partition in descending order of the given attribute's value for inclusion in the subset until the maximum number of database objects has been selected for that partition and verifying that the global constraint has been met.

67. The method of claim 64 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a maximum number of database objects in the subset and input local constraint is a minimum number of database objects selected per partition of database objects in the subset and wherein the method comprises selecting database objects in each partition in descending order of the given attribute's value for inclusion in the subset until exactly the minimum number of database objects has been selected for that partition and verifying that the global constraint has been violated and if it has not selecting additional database objects in descending order of the given attribute until no more database objects can be added to the subset without violating the global constraint.

68. The method of claim 64 wherein the optimization criteria is a maximization of a given attribute and wherein the input global constraint is a maximum number of database objects in the subset and input local constraint is a maximum number of database objects selected per partition of database objects in the subset and wherein the method comprises selecting database objects in each partition in descending order of the

given attribute's value for inclusion in the subset until the maximum number of database objects has been selected according to the global constraint and verifying that the global constraint has been met.

70. The method of claim 64 wherein the optimization criteria is a minimization of a count of database objects in the subset wherein the subset of database objects must meet a plurality of constraints each having a corresponding attribute that is constrained and wherein the method comprises selecting database objects for inclusion in the subset by scanning, one time for each constraint, the database objects in descending order of the corresponding attribute for that constraint, and selecting database objects until the constraint is met.

71. One or more computer readable media comprising computer executable instructions for performing the method of claim 50.

72. One or more computer readable media comprising computer executable instructions for selecting a subset from a plurality of database objects having associated attributes, the instructions comprising:

inputting an optimization criteria that is an aggregate function over one or more database object attributes to be optimized by database objects in the subset; and

applying the optimization criteria to the plurality of database objects to select a subset of database objects that optimize the criteria.

73. The computer readable media of claim 72 wherein the instructions comprise partitioning the plurality of database objects on a partitioning attribute and applying the optimization criteria separately to database objects in each partition.

74. The computer readable media of claim 72 wherein the instructions comprise inputting a global constraint over the attributes of database objects in the subset.

75. The computer readable media of claim 73 wherein the instructions comprise inputting a local constraint over the attributes of database objects in each partition.

76. The computer readable media of claim 72 wherein the instructions comprise inputting a filter constraint on each database object that can be selected to the subset.

77. The computer readable media of claim 72 wherein the instructions comprise inputting a ranking order that orders the database objects according to an attribute value and applying optimization criteria to the ordered database objects.

78. The computer readable media of claim 72 wherein the instructions comprise randomly sampling the database objects select a subset that optimizes the optimization criteria.

79. An apparatus for selecting a subset of a plurality of database objects having associated attributes comprising:

- means for inputting an optimization criterion that is an aggregate function over one or more database object attributes;
- means for solving the optimization criteria with respect to the database objects; and
- means for selecting as the subset a set of database objects that satisfy the optimization criteria.

80. The apparatus of claim 79 comprising means for partitioning the database objects into partitions based on a partitioning attribute; wherein database objects in the partition have equivalent values for the partitioning attribute and also comprising means for applying the optimization criterion separately for each partition.

81. The apparatus of claim 79 comprising means for inputting a global constraint on the attributes of the database objects in the subset.

82. The apparatus of claim 80 comprising means for inputting a local constraint on the attributes of the database objects in the subset for each partition.

83. The apparatus of claim 80 comprising means for inputting a filter constraint that must be met with respect to each database object selected for the subset.

84. The apparatus of claim 80 comprising means for inputting an order, based on attribute values, in which database objects are accessed by the optimization criteria solver for possible selection to the subset.

85. A workload summarization system that selects a subset of a plurality of database queries having query attributes comprising:

a dominance database operator that inputs a partial order criterion for an attribute whereby a master database query in the plurality dominates an associated slave database query; and applies the partial order criterion to the database query attributes and eliminates all slave database queries that do not dominate their associated master database query from the subset; and

a representation database operator that that inputs an optimization criterion that is an aggregate function over one or more database object attributes; and determines and selects as the subset a set of database objects that satisfy the optimization criteria.

86. The workload summarization system of claim 85 comprising a partitioning module that partitions the database objects into partitions based on a partitioning attribute; wherein database objects in the partition have equivalent values for the partitioning attribute and wherein the dominance and representation operators act separately on each partition.

87. The workload summarization system of claim 85 wherein the representation operator inputs a global constraint on the attributes of the database objects in the subset.

88. The workload summarization system of claim 86 wherein the representation operator inputs a local constraint on the attributes of the database objects in the subset for each partition.

89. The workload summarization system of claim 85 wherein the representation operator inputs a filter constraint that includes an aggregate function of an attribute of the database objects being acted upon by the representation operator.

90. The workload summarization system of claim 85 wherein the representation operator inputs an order, based on attribute values, in which database objects are accessed by the representation operator for possible selection to the subset.

91. The workload summarization system of claim 85 wherein the representation operator calls an integer programming solver to select database queries that optimize the optimization criteria.

92. The workload summarization system of claim 85 wherein the dominance operator aggregates information about slave database objects that the master database object dominates.

93. The workload summarization system of claim 85 wherein the partial order criterion comprises a conjunction of one or more transitive inequality conditions.